Iowa Department of Transportation

MINUTES OF SPECIFICATION COMMITTEE MEETING

May 16, 2002

Members Present:	John Adam, Director	Statewide Operations Bureau
	Tom Reis, Chair	Specifications Section
	Jim Berger	Office of Materials
	Larry Jesse	Office of Local Systems
	Mike Kennerly	Office of Design
	Keith Norris	District 2 Materials
	Gary Novey	Office of Bridges and Structures
	John Smythe	Office of Construction
Members Not Present:	Roger Bierbaum	Office of Contracts
	Steve Gent	Office of Traffic and Safety
	Bruce Kuehl	District 6, Construction Engineer
	Doug McDonald	Marshalltown RCE
From FHWA:	Manu Chacko	
Others Present:	Donna Buchwald, Secretary	Specifications Section
	Steve Akes	Warren County
	Dale Harrington	CTRE
	Kevin Jones	Office of Materials
	Steve Meyer	Highway Division Support Team
	Norm Miller	District 1, Survey
	Will Stein	Office of Design
	Francis Todey	Office of Design
	Kurtis Younkin	Office of Traffic and Safety

Tom Reis, the Specifications Engineer, opened the meeting. The following items were discussed in accordance with the May 9, 2002, agenda:

1. CAST Update

a. Values

No change from previous meeting.

b. Progress Reports

1. Project Supervision: John Smythe

At a meeting with the AGCI Business Practices Meeting on May 15, John discussed the Construction Quality Management approach. The group did not appose the

concept. John asked the group to identify a small group of contractors that could work with the Department to define what kind of program in this area is desired. The Department is anticipating the program development and training completed this fall so it may be included on some projects in this winter's letting.

2. Pre-letting: Francis Todey/Tom Reis

Shoulder Aggregate:

A Supplemental Specification for Furnish and Apply Granular Shoulder Material was completed for the March letting. There were 18 shoulder aggregate projects in the March letting. One project was rejected and no bids were received on another. Districts 2 and 6 participated. District 1 has projects scheduled in the June letting.

On-Call Contracting - Patching:

Supplemental Specifications for On-Call Contracting - Patching have been completed and the Office of Contracts sent the bid information to all the District Offices with a spread sheet so that the Districts can start planning their projects for implementation of this process. Francis sent an e-mail with more description on what is expected and what they will need to do. Next week Francis will meet with the Assistant District Engineers to again discuss the process.

This process may be expanded to the local agencies in the future.

3. Materials and Audits: Kevin Jones

No change from previous meeting.

4. Plan Improvement Team: Roger Gould/Tom Reis

The Specification Section will not be able to make changes to the pavement items for the October 29, 2002, letting, due to a heavy work load. The Specification Section will work with the Office of Design to eliminate separate payment for pipe appurtances, which will be included in the linear foot (meter) price of the pipe.

The Office of Bridges and Structures is reviewing the structural steel items to determine if it is possible to change all structural steel to one lump sum item. The weight (mass) of the main girders will be determined, then a predetermined percentage will be used to calculate the remaining components. The Office of Bridges and Structures is currently working on determining that percentage and if enough consistency exists. It was suggested that structural steel remain a plan quantity item with the weight (mass) of the main girders as the quantity, and all the remaining components incidental to it. The Office of Bridges and Structures will work with the Office of Contracts to determine the best method.

The Office of Construction is also working with the Office of Design to review all of the Change Orders. After this is completed, the Offices may have other recommendations to the approved plan quantity list.

5. Technology and Innovation: Tom Reis

No change from previous meeting.

6. **Training: John Smythe**
   The Office of Construction developed a two day training session on Basic Construction Administration for each District's Maintenance personnel. This training has been completed for this year. More training will be needed next year, with concentration in the area of plan reading.

c. Work Plan, Milestones, and Time Line
No change from previous meeting.

d. Communication

1. **Industry**
   The Office of Construction has continued to present CAST changes to the industries and has not received any complaints.
2. **Employees**
   No change from previous meeting.
3. **Counties & cities**
   No change from previous meeting.

e. Miscellaneous
No comments.

2. Article 1101.02 Definitions of Abbreviations.

The Office of Construction requested a change to Article 1101.02 that will correct an error in the abbreviation definitions of the Standard Specifications.

Submitted by: John Smythe **Office:** Construction **Date:** May 6, 2002

Proposed Effective Date: October 29, 2002

Article No.: 1101.02 **SS No.:** **Other:**

Change (Redline/Strikeout):
Correct abbreviation “ACT” to “ACI”; this is the American Concrete Institute

Reason for revision:

County or City Input Needed ☐
County or City Comments:

No industry input needed X **Industry notified** ☐ **Industry Concurrence** ☐
Industry Comments:

Specification Section Use Only:

Specification Section Recommended Language:

Specification Section Comments:

Final Approved Text:
Replace “ACT” with “ACI” in the list of abbreviations.

Comments: No discussion. Rules Committee approval required.

Specification Committee Action:

Deferred: ☐ **Not Approved:** ☐ **Approved Date:** 5-16-02 **Effective Date:** 10-29-02 or later.

3. Article 2403.01, A, Description Class D Concrete.
4. Article 2403.01, C, Description Class C Concrete.

The Office of Construction requested a change to Article 2403.01 that will correct an oversight in the specifications for the class of concrete used for sidewalks associated with bridge structures.

Submitted by: John Smythe **Office:** Construction **Date:** May 6, 2002

Proposed Effective Date: October 29, 2002

Article No.: 2403.01, A, and 2403.01, C **SS No.:** **Other:**

Change (Redline/Strikeout): ~~Bridge curbs and medians, bridge barrier rails and sidewalks of bridges shall be Class D concrete.~~ Bridge barrier rails of bridges shall be Class D concrete.

~~Refer to Article 2412.02 for concrete used for one course bridge floors and the first course of two course bridge floors. All other structural concrete shall also be Class C concrete.~~ Refer to Article 2412.02 for concrete used for one course bridge floors and the first course of two course bridge floors. All other structural concrete, including concrete for bridge curbs, bridge medians, and bridge sidewalks, shall also be Class C concrete.

Reason for revision: Many years ago we changed from Class D to Class C concrete mix for bridge decks. The Class of concrete for sidewalks associated with bridge structures should also be specified as Class C for consistency and constructability.

County or City Input Needed ☐
County or City Comments:

No industry input needed X **Industry notified** ☐ **Industry Concurrence** ☐
Industry Comments:

Specification Section Use Only:

Specification Section Recommended Language:

Specification Section Comments:

Final Approved Text:

2403.01, A

Replace the entire article.

~~Bridge curbs and medians, bridge barrier rails and sidewalks of bridges shall be Class D concrete.~~ Bridge barrier rails shall be Class BR or Class D concrete.

2403.01, C

Replace the entire article.

~~Refer to Article 2412.02 for concrete used for one course bridge floors and the first course of two course bridge floors. All other structural concrete shall also be Class C concrete.~~ Refer to Article 2412.02 for concrete used for one course bridge floors and the first course of two course bridge floors. All other structural concrete, including concrete for bridge curbs, bridge medians, and bridge sidewalks, shall also be Class C concrete.

Comments:

At the meeting the Office of Construction requested that Class BR be added to the proposed Specification as it is the preferred concrete for bridge rails.

The Committee discussed changing the Class D requirement to Class C, since the required

strengths are being achieved with Class C. Class D also has other problems with workability and shrinkage. The Office of Construction will review the requested change from Class D to Class C; and if supportive they will submit a request for change at a later date.

Specification Committee Action:

Deferred: ☐ **Not Approved:** ☐ **Approved Date:** 5-16-02 **Effective Date:** 10-29-02.

5. Article 2412.07, Curing.

The Office of Construction requested a change to Article 2412.07 that will require the wet cure process to begin within 10 minutes of the finishing and application of the curing compound.

Submitted by: John Smythe **Office:** Construction **Date:** May 6, 2002

Proposed Effective Date: October 29, 2002

Article No.: 2412.07 **SS No.:** **Other:**

Change (Redline/Strikeout): REVISE SECOND SENTENCE OF FIRST PARAGRAPH: ~~As soon as it can be placed without marring the surface, a layer of prewetted burlap shall be placed on the concrete.~~ Two layers of prewetted burlap shall be placed on the floor within 10 minutes after final finishing (texturing) and covering of concrete with white pigmented curing compound.

Reason for revision: Expediting the wet cure process is very important to eliminate the potential for plastic concrete shrinkage/cracking and to ensure successful concrete strength development.

County or City Input Needed ☐
County or City Comments:

No industry input needed **Industry notified** ☐ **Industry Concurrence** ☐
Industry Comments:

Specification Section Use Only:

Specification Section Recommended Language:

Specification Section Comments:

Final Approved Text:

Replace the second sentence of the first indented paragraph.

~~As soon as it can be placed without marring the surface, a layer of prewetted burlap shall be placed on the concrete.~~ The first layer of prewetted burlap shall be placed on the floor within 15 minutes after final finishing (texturing) and covering of concrete with white pigmented curing compound. The Engineer may adjust the time for placement of the first layer of prewetted burlap to minimize burlap damage to the transverse grooving.

Comments:

The Specification Committee changed the proposed requirement for two layers of prewetted burlap to only requiring the first layer of prewetted burlap be placed within 10 minutes. This will allow the second layer be placed within 2 hours, stated else where in the Specifications.

The white curing compound will still be required incase something happens to the sprinkler system and premature drying of the burlap. Continuing with the curing compound requirement is an inexpensive insurance.

Note: After the meeting, the Office of Construction requested the placement time be changed from 10 minutes to 15 minutes. They also requested the last sentence be added to allow the Engineer discretion on choosing the optimum time for the burlap to be applied.

Specification Committee Action:

Deferred: ☐ **Not Approved:** ☐ **Approved Date:** 5-16-02 **Effective Date:** 10-29-02.

6. Article 2511.03, Concrete and Proportions.

The Office of Construction requested a change to Article 2511.03 that will correct an oversight in the specifications for the class of concrete used for sidewalks associated with bridge structures.

Submitted by: John Smythe **Office:** Construction **Date:** May 6, 2002

Proposed Effective Date: October 29, 2002

Article No.: 2511.03 **SS No.:** **Other:**

Change (Redline/Strikeout): Revise the second paragraph.
~~When construction of a sidewalk is associated with a bridge structure the concrete used shall be Class D produced and placed in accordance with Section 2403.~~ When construction of a sidewalk is associated with a bridge structure the concrete used shall be Class C produced and placed in accordance with Section 2403.

Reason for revision: Many years ago we changed from Class D to Class C concrete mix for bridge decks. The Class of concrete for sidewalks associated with bridge structures should also be specified as Class C for consistency and constructability.

County or City Input Needed ☐
County or City Comments:

No industry input needed **Industry notified** ☐ **Industry Concurrence** ☐
Industry Comments:

Specification Section Use Only:

Specification Section Recommended Language:

Specification Section Comments:

Final Approved Text:
Replace "Class D" with "Class C" in the second paragraph.

Comments:

Specification Committee Action:

Deferred: ☐ **Not Approved:** ☐ **Approved Date:** 5-16-02 **Effective Date:** 10-29-02.

7. Article 2513.03, B, 4, Admixtures.

The Office of Materials requested a change to Article 2513.03 that will make the air entraining requirements consistent with the precast barrier rail in order to solve problems of low air content.

Submitted by: Todd Hanson **Office:** Materials **Date:** April 12, 2002

Proposed Effective Date: October 29, 2002

Article No.: 2513.03, B, 4 **SS No.:** **Other:**

Change (Redline/Strikeout): Change The air content of fresh, unvibrated concrete shall be ~~6.5%~~7.0%, as a target value, with a maximum variation of ~~+/- 1.0%~~plus 1.5% and minus 1.0%.

Reason for revision:

County or City Input Needed ☐
County or City Comments:

No industry input needed **Industry notified** ☐ **Industry Concurrence** ☐
Industry Comments:

Specification Section Use Only:

Specification Section Recommended Language:

Specification Section Comments:

Final Approved Text:

Replace the third sentence:

The air content of fresh, unvibrated concrete shall be ~~6.5%~~ 7.0%, as a target value, with a maximum variation of ~~± 1.0%~~ plus 1.5% or minus 1.0%.

Comments:

The Office of Materials made this request for consistency with the pre-cast concrete barrier rail requirements.

Specification Committee Action:

Deferred: ☐ **Not Approved:** ☐ **Approved Date:** 5-16-02 **Effective Date:** 10-29-02.

8. Article 2527, Construction Survey

The Office of Construction requested a discussion concerning the potential for utilizing stakeless construction techniques.

Submitted by: John Smythe **Office:** Construction **Date:** May 1, 2002

Proposed Effective Date: discussion topic

Article No.: **SS No.:** **Other:** Section 2526

Change (Redline/Strikeout): I recommend we include a discussion on stakeless construction at the next specification meeting. The current specification for contract survey is very specific about the stakes that must be placed. I would anticipate that we will be getting requests to use stakeless construction at some point in the future, especially in Polk County, and would like to have the specification reflect the requirements when this technology is used. I don't have recommended language at this point, but feel a discussion on how to define the requirements so there is something out there for inspectors to use to "check" the work should occur as soon as possible. The outcome of the meeting may be a plan on how to move forward. Since Design would have to provide the electronic files, I assume they will need input into this plan. I don't want the specifications to indicate stakeless construction is an option until we are satisfied the design files can be provided. Also, perhaps a representative from District 1 Land survey should attend, since they have much more knowledge of how this works. I have also copied Dennis Peperkorn, who may be interested in this discussion.

Presently, Trimble has a product called SiteVision that takes a Geopak output file and creates a 3D model in their data collectors. This interfaces with GPS units on grader and scraper blades to allow for stakeless construction. Geopak will also output a TIN file that Trimble uses in their data collectors that would allow an inspector to walk, with a GPS unit, to any location on a given job and get an elevation plus/minus 1 cm, as it relates to the proposed construction elevation. This would let the inspector "check" the work. If you need, I can supply more information about this process.

Reason for revision:

County or City Input Needed ☐
County or City Comments:

No industry input needed **Industry notified** ☐ **Industry Concurrence** ☐
Industry Comments:

Specification Section Use Only:

Specification Section Recommended Language:

Specification Section Comments:

Final Approved Text:

Comments:

GPS survey can provide a 0.1 foot or less vertical accuracy. A portable base can be used for the radio broadcast during the times that the radio broadcast is not working.

Each project will need to be calibrated. It is recommended that a project be calibrated a minimum of every 5 miles. A calibration sets control points. It is recommended that control points be set every 1/2 mile for horizontal control and every 1/2 mile for vertical control.

There are 3 to 4 spikes per day that GPS should not be used for survey. These spikes last 10 to 20 minutes and are predictable up to 2 months in advance. The spikes are caused by less than 5 satellites being viewable. The Department's equipment will not function during these spikes, it is unsure how other equipment responds.

Currently this new process is being used regularly by the City of West Des Moines. It is being used on grading projects, but its use on paving is unknown. Washington County is currently writing a proposal to use GPS survey on a paving project. See Attachment A.

It was recommended from the field that with the reduction in forces the Department has experienced in the field that GPS survey is a perfect tool to help eliminate setting hundreds of stakes on projects. This would also help eliminate some of the costs of contract survey. There will be cost and training issues.

GeoPak, the Department's civil design software which has the capability of exporting a TIN (Triangulated Irregular Network) file to the GPS survey equipment. These files are a 3-D contour file showing how the grading project should look. The accuracy of these files carries out to 16 places. The information will only be as accurate as the design file. If there is an error in the plans, it will be included in this file. The design file can be checked by "driving" the project after the TIN file is developed. The Designer should perform this check because they should be the most familiar with how their project should look.

GeoPak is currently working with the Nebraska Department of Roads to develop a XML (Extendable Markup Language) output file, which can be downloaded directly into a data collector. Several suppliers of data collectors, i.e.Trimble, TDS, and Geodimeter, can utilize this information and are working with GeoPak on this project..

The Department will have to determine a method of independent checking. Currently the field checks its own work using a different set of satellites on the same points; although this would not help check for errors in the design.

Specification Committee Action:

Proposed language at June Specification Committee meeting.

Deferred: X Not Approved: ☐ Approved Date: Effective Date:

9. Section 2527, Pavement Marking
Article 4183.04, Epoxy Traffic Paint

The Office of Traffic and Safety requested several changes to Section 2527 and Article 4183.04 that will allow for grooved pavement markings to be used for all pavement marking types and also incorporates defective pavement marking language into the Standard Specifications.

Submitted by: Kurtis Younkin/Steve Gent **Office:** Traffic and Safety **Date:** May 3, 2002

Proposed Effective Date: October 29, 2002

Article No.: 2527 and 4183.04 **SS No.:** **Other:**

Change (Redline/Strikeout): See Attachment B.

Reason for revision: To incorporate changes for durable paint pavement markings (which are currently covered under a special provision) into the general specifications.

This revised spec also allows the grooving specification to be applied to all pavement markings if specified, instead of only to profiled marking tape. The change makes the defective marking section applicable to all markings instead of specific only to epoxy.

County or City Input Needed ☐
County or City Comments:

No industry input needed **Industry notified** ☐ **Industry Concurrence** ☐
Industry Comments:

Specification Section Use Only:

Specification Section Recommended Language:

2527.02, B, 2, Epoxy.

Replace the title and entire article:

2. ~~Epoxy~~ Durable Paint Pavement Markings.
~~Epoxy traffic paint~~ Durable paint pavement markings shall meet requirements of Section 4183 ~~for epoxy paint. The epoxy paint pavement marking material shall be heated to the manufacturer's recommendation temperature before application to the pavement.~~

~~Epoxy pavement markings shall have a targeted thickness of 20 mils (500 µm) with an acceptable range of 19 to 25 mils (475 µm to 625 µm) without the glass beads. Glass beads shall be applied at a rate of at least 25 pounds of beads per gallon (3 kg/L) of paint. A heavier bead application may be necessary to achieve the minimum retroreflectivity requirements.~~ The marking thickness and reflective beads shall be applied according to Materials I.M. 483.04.

2527.03, Construction.

Replace "epoxy" with "durable paint" in the third paragraph.

Delete the last sentence of the fourth paragraph:
~~For tape products, the manufacturer's recommendations shall be followed for surface dryness and other surface preparation requirements.~~

Add a new sixth paragraph with subparagraphs:

For tape products, the manufacturer's recommendations shall be followed for surface dryness, primers, adhesives, and other surface preparation requirements. Unless otherwise specified by the tape manufacturer the following test shall be met for determining surface dryness before applying the tape.

1) In an area of direct sunlight where the tape will be applied, place an 18 inch x 18 inch (450 mm x 450 mm) piece of polyethylene (a green or black garbage bag may be used). There should not be any holes or tears in the polyethylene.

2) Tape down all the edges of the polyethylene sheet to seal all the edges and not allow any air movement to get under the polyethylene.

3) Firmly tamp the tape using the tamper cart or by foot tamping.

4) Allow 20-25 minutes for the polyethylene to be exposed to the direct sunlight.

5) Remove the polyethylene from the road surface. If no moisture is present on the under side of the polyethylene or on the road surface, the tape can be applied.

6) If any moisture is present, allow another hour to pass and repeat the test until no moisture is found.

2527.03, B, Removal of Pavement Markings.

Replace the second sentence of the third paragraph:

Tightly adhering markings may remain in the bottom of the tining and other depressions on the pavement surface but shall not be visible to the motorist during daytime or night time.

2527.03, D, Limitations.

Replace the seventh paragraph:

When the installation of preformed polymer pavement marking material or profiled pavement marking tape is in conjunction with placement of hot mix asphalt mixtures, the ~~preformed polymer~~ tape shall be inlaid by positioning on the hot mixture prior to the final rolling. The installation of ~~preformed polymer marking material~~ the tape shall be in accordance with the manufacturer's recommendations. If grooving is specified, tape shall not be inlaid into hot asphalt.

2527.03, H, Defective Epoxy Paint Pavement Markings.

Replace the title.

H. Defective ~~Epoxy Paint~~ Pavement Markings.

Replace the first paragraph:

Markings that are low on initial retroreflectivity up to 20%, may at the discretion of the Engineer, be accepted with a price adjustment ~~equal to the percent below the minimum retroreflectivity level. For example, if a section of marking is 15% below the minimum, the price paid for that section would be reduced by 15%~~.

Delete “epoxy paint” from the third paragraph.

2527.03, H, 1, Insufficient Film Thickness, Line Width, or Low Retroreflectivity.

Delete the entire article.

Repair Method. Prepare the surface of the defective epoxy paint marking using methods found in Article 2527.03. Surface preparation shall be performed to the extent that a substantial amount of the retroreflective glass beads are removed and a roughened epoxy marking surface remains. Repair shall be made by restriping over the cleaned surface in accordance with the requirements of these specifications and at the full thickness.

2527.03, H, 2, Insufficient Bond.

Delete the entire article.

Repair Method. The defective epoxy paint marking shall be completely removed and cleaned to the underlying pavement surface in accordance with the requirements of Article 2527.03. The extent of removal shall be the defective area plus any adjacent epoxy paint pavement marking material extending 1 foot (300 mm) in any direction. After surface preparation work is complete, repair shall be made by reapplying epoxy paint over the cleaned pavement surface in accordance with the requirements of these specifications.

2527.03, I, Surface Preparation for Profiled Marking Tapes.

Replace the title.

I. Surface Preparation for Profiled Marking Tapes Grooving for Pavement Markings.

Replace the first sentence of the first paragraph:

All profiled When specified, pavement markings shall be placed in a groove cut into the pavement surface.

2527.03, I, 2, Groove depth.

Replace the entire article.

0.065 inches ± 0.020 inches (1.6 mm ± 0.5 mm) For profiled marking tape the grooved depth shall be 0.080 inches ± 0.010 inches (2.0 mm ± 0.03 mm).

For all other markings, the groove depth shall be as recommended by the pavement marking manufacturer.

2527.03, I, 6, a, Moisture Test of Pavement Surface.

Delete the title and entire article.

a. Moisture Test of Pavement Surface.

1) In an area of direct sunlight where the tape will be applied, place an 18 inch x 18 inch (450 mm x 450 mm) piece of polyethylene (a green or black garbage bag can be used). There should not be any holes or tears in the polyethylene.

2) Tape down all the edges of the polyethylene sheet using duct tape or pavement marking tape. The tape should seal all the edges and not allow any air movement to get under the polyethylene.

3) Firmly tamp the tape using the tamper cart or by foot tamping.

4) Allow 20-25 minutes for the polyethylene to be exposed to the direct sunlight.

5) Remove the polyethylene from the road surface. If no moisture is present on the back side of the polyethylene or on the road surface, the tape can be applied.

~~**6)** If any moisture is present, allow another hour to pass and repeat the test until no moisture is found.~~

2527.03, I, 7, Adhesive.

Delete the title and entire article.

~~**7. Adhesive.**~~

~~The Contractor shall apply adhesive according to the manufacturer's instructions.~~

2527.05, K, Grooves Cut for Tape.

Replace the title and entire article.

K. Groove s Cut for ~~Tape~~ Pavement Markings.

~~For Grooves Cut for Profiled Marking Tape, t~~ The Engineer will measure the number of stations (meters) of grooves cut for ~~tape~~ pavement markings. This quantity will be equivalent to the number of stations (meters) measured for the ~~Tape~~ pavement markings. Additional width and transition length will be incidental.

2527.05, L, Grooves Cut for Symbols and Legends.

Replace the first sentence.

~~For grooves cut for profiled marking tape t~~ The Engineer will count the number of Grooves Cut for Symbols and Legends placed.

2527.06, K, Grooves Cut for Tape.

Replace the title.

K. Grooves Cut for ~~Tape~~ Pavement Markings.

4183.04, Epoxy Traffic Paint.

Replace the title.

Epoxy Traffic Paint Durable Paint Pavement Markings.

Replace the first paragraph.

~~Epoxy traffic paint~~ Durable paint pavement markings shall meet the requirements of Materials I.M. 483.04.

Specification Section Comments: The above changes to 2527.03, I, 2, will replace those made in Item 6 at the April 11, 2002, Specification Committee meeting.

Final Approved Text:

All the above text was approved with the following corrections and changes:

2527.02, B, 2, Epoxy.

Replace the title and entire article:

2. ~~Epoxy~~ Durable Paint Pavement Markings.

~~Epoxy traffic paint~~ Durable paint pavement markings shall meet requirements of Article 4183.04 ~~for epoxy paint. The epoxy paint pavement marking material shall be heated to the manufacturer's recommendation temperature before application to the pavement.~~

~~Epoxy pavement markings shall have a targeted thickness of 20 mils (500 µm) with an acceptable range of 19 to 25 mils (475 µm to 625 µm) without the glass beads. Glass beads shall be applied at a rate of at least 25 pounds of beads per gallon (3 kg/L) of paint. A heavier bead application may be necessary to achieve the minimum~~

~~retroreflectivity requirements.~~ The marking thickness and reflective beads shall be applied according to Materials I.M. 483.04.

4183.04, Epoxy Traffic Paint.

Replace the title.

~~Epoxy Traffic~~ Durable Paint Pavement Markings.

Comments:

Grooving will not be used on all projects but will only be used on specific projects when specified. It will cost more to perform the grooving, but the Department will specify it in areas of high volume. It will also be specified at intersections where there is difficulty holding markings and then it will be required because of safety.

The grinding equipment will be treated as any other construction equipment and not be allowed on the pavement until the strength requirements are achieved.

Specification Committee Action:

Deferred: ☐ **Not Approved:** ☐ **Approved Date:** 5-16-02 **Effective Date:** 10-29-02.

ATTACHMENT A

Draft 2/21/02 –IPRF TASK #7 IDEA

TITLE: Applying GPS Technology to the Paving Train

INTRODUCTION/BACKGROUND: Current pavement construction technology employs the use of physical guidance systems in the form or a string or wire line on one or both sides of the slipform paver. This system provides both the horizontal and vertical control for the machine to place the required pavement thickness and in the required location. It also creates a need for space on each side of the paving machine to set the survey control line near the paver. Spacing of the control line stakes can also have a positive or negative impact on the smoothness of the final pavement surface. The actual placement and verification of the physical guidance systems on each side of the paving machine cost time, manpower and limit access to the area in front of the slipform paver.

LITURATURE SEARCH, past present and future

RESEARCH PROBLEM STATEMENT: Washington County Iowa has long been a leader in concrete paving technology and is ready to look at advancement in the area of concrete placement. They have spent monies to provide GPS level control to a section of highway in an effort to reduce the amount of staking required to both grade and pave the project. GPS control of the slipform paver should provide both vertical and horizontal control to the machine and eliminate the need for control staking and line on each side of the pavement construction area. In this case the same control used for the development of the graded cross section will be used for the paver control. Can GPS be used to control the horizontal and vertical alignment of the paver and provide a smooth riding surface for the final product? This is the question that the research seeks to answer.

RESEARCH OBJECTIVES: The objectives deal with the evaluation of the GPS application relative to the use of conventional survey techniques and manual stringline placement and control to obtain a smooth and required depth in paving.

1. Evaluation of the use of GPS control to guide the slipform paver in the alignment and depth control of the final Portland cement concrete pavement.

PROPOSED RESEARCH: The research would take form of the following activities:

1. County survey of the existing graded surface using both GPS and conventional survey techniques to determine the variations in elevations across the pavement and along the pavement area prior to the beginning of paving. This would be done to also establish the horizontal alignment and verify that GPS placed the pavement on the graded surface.
2. Contractor placement of GPS control equipment on each edge of the paver to sense and control the elevation and location of the pavement edges.
3. Use of QC/QA concrete specifications for the project.
4. Concrete to be paid for by the cubic yard and square yard to reduce the risk to the contractor for placement depths.
5. County survey of the final paved surface to verify the vertical and horizontal alignment of the final pavement surface at the edges and centerline.
6. Use of the Iowa DOT roadmeter to establish the final road surface profile in the outer wheelpath of the roadway in each direction.
7. Random coring of the final pavement surface to determine the depth of placement relative the final surface elevations.
8. Diamond grinding of the pavement surface if and where necessary to meet smooth specifications.

EVALUATION --TESTING

1. Survey, GPS and conventional on the finished graded surface and finished paved surface to

establish and verify vertical and horizontal control were established and met.
2. Roadmeter testing for profile of the finished surface in the outside wheelpath in each direction to establish a level of smoothness obtained.
3. Random coring of the pavement surface to determine depth relative to the required depth.

ESTIMATE OF COST:
1. Surveying – additional cost to the county (this also establishes a reference for savings)
2. Diamond grinding option – (cost per square yard for the entire project if necessary)
3. The contractor and the county through the use of this technique could realize savings in survey and staking. Some measure of the cost of the GPS control relative to the grading and paving operation.

RESEARCH PERIOD: January 1, 2003 – December 31, 2003

REPORTS: One construction/final report on the construction techniques and the resulting pavement product relative to line, grade and depth control. The report would document the preconstruction survey, construction operations and the post survey work. It would also investigate the analysis of variance in the data gained from the survey, roadmeter and coring operations as related to conventional methods.

PROJECT STAFFING:
1. Jim Cable, ISU/CCE
2. Bob Bauer, Washington County Engineer and survey crew
3. Ed Jaselskis, ISU/CCE and one Graduate student
4. GPS consultants and paving contractor

IMPLEMENTATION: This method can revolutionize the paving in state, county and city paving in areas of limited right of way. It has the potential to eliminate human error in conventional ground surveys and slipform paver control staking. This relates to application in up to 10,000 miles of county road pavements in Iowa alone. It also relates to providing faster construction of construction of concrete pavements with less effort and funds being expended in alignment control and more in the product being placed.

ATTACHMENT B

2527.01 DESCRIPTION.
This work involves the furnishing, installation, maintenance, and removal of permanent or temporary pavement markings, temporary delineators, and raised pavement markers, such as:

A. For diversions and on site detours where the need for this work is anticipated as part of the traffic control plan to accommodate traffic during construction.

B. For replacing markings obliterated during construction activities on roads open to public traffic.

C. For changing markings on roads open to public traffic where the necessary changes result from staged construction.

D. For replacing markings that are obsolete.

E. For marking of completed pavement surfaces.

Permanent pavement markings are those intended to remain in place after the project is completed. Temporary markings are those that are designated for removal, those that will be obliterated during construction, or those that require changes during construction.

Diversions are installations or modifications for the transfer of traffic on four lane or wider roadways to lanes which would normally carry traffic in the opposite direction. Diversions provide for continuous but restricted traffic flow from both directions for divided highways. Diversions usually include crossovers.

On site detours are temporary roadways specifically constructed to accommodate traffic during construction.

2527.02 MATERIALS.
The materials used for pavement marking shall provide markings that are readily visible when viewed in daylight and with vehicular headlights at night.

The marking materials used for temporary pavement marking include removable marking tape, traffic paint, temporary delineators, and raised pavement markers. Unless otherwise specified, the marking materials used for permanent pavement marking include regular marking tape, traffic paint, and preformed polymer pavement marking material.

Other marking materials, such as epoxy, polyester, or thermoplastic, etc., may be specified in the contract documents.

The material for pavement markings are described below:

A. Removable Marking Tape.
Removable marking tape shall have a nominal width of 4 inches (100 mm) and shall consist of a yellow or white, weather and traffic resistant film, precoated on one side with a pressure sensitive adhesive. The tape shall be flexible and formable and shall be capable of remaining in place during its useful life and shall be easily removed from the pavement at any time.

Removable marking tape shall be prequalified for use in accordance with Materials I.M. 483.06 and meet the requirements of Article 4183.06, A.

B. Traffic Paint.
The painting equipment shall be capable of placing two lines simultaneously with either line in a solid or intermittent pattern in yellow or white and of applying glass beads at the required rate. All guns must be in full view of the operator at all times. The equipment shall be provided with a metering device to register the accumulated length for each gun, each day. Equipment shall have such a

design that the pressure gauges for each proportioning pump are visible to the operator at all times during operation to monitor fluctuations in pressure.

Reflectorizing spheres meeting requirements of Section 4184 shall be applied to the painted lines. The paint shall be applied without dilution using mechanical equipment intended for that purpose. The reflectorizing spheres shall be applied immediately to the wet paint with a pressurized system.

1. Waterborne and Solvent-based Paint.
Waterborne and solvent-based paint shall meet the requirements of Section 4183 for fast dry paint.

The nominal application paint and glass bead rates shall be as follows:

Waterborne Paint

Line Width	Wet-Film Thickness	Paint	Spheres
4 1/2" (115 mm)	14 mils (0.35 mm)	305.5 ft. of solid line per gallon of paint. (24.60 m of solid line per liter of paint.)	9.0 lb./gal. (1.08 kg/L)
4" (100 mm)	14 mils (0.35 mm)	343.7 ft. of solid line per gallon of paint. (27.68 m of solid line per literof paint.)	9.0 lb./gal. (1.08 kg/L)

Solvent-based Paint

Line Width	Wet-Film Thickness	Paint	Spheres
4 1/2" (115 mm)	16 mils (0.41 mm)	267.4 ft. of solid line per gallon of paint. (21.53 m of solid line per liter of paint.)	9.0 lb./gal. (1.08 kg/L)
4" (100 mm)	16 mils (0.41 mm)	300.8 ft. of solid line per gallon of paint. (24.22 m of solid line per liter of paint.)	9.0 lb./gal. (1.08 kg/L)

2. ~~Epoxy~~ Durable Paint Pavement Markings.
~~Epoxy traffic paint~~ Durable paint pavement markings shall meet requirements of Section 4183.04 for epoxy paint. ~~The epoxy paint pavement marking material shall be heated to the manufacturer's recommendation temperature before application to the pavement.~~

~~Epoxy pavement markings shall have a targeted thickness of 20 mills (500 µm) with an acceptable range of 19 to 25 mills (475 µm to 625 µm) without the glass beads. Glass beads shall be applied at a rate of at least 25 pounds of beads per gallon (3kg/L) of paint. A heavier bead application may be necessary to achieve the minimum retroreflectivity requirements.~~ The marking thickness and reflective beads shall be applied according to Materials I.M. 483.04.

C. Regular Marking Tape.
Regular marking tape shall have a nominal width of 4 inches (100 mm) and shall consist of a yellow or white, weather and traffic resistant film on a conformable, metallic foil backing precoated with a pressure sensitive adhesive. The tape shall be flexible and formable, and following application, shall remain conformed to the texture of the pavement surface.

Regular marking tape shall be prequalified for use in accordance with Materials I.M. 483.06 and meet the requirements of Article 4183.06, B.

D. Temporary Delineators.
Temporary delineators shall meet requirements of Article 4186.07 and shall be mounted on posts meeting the requirements of Article 4186.10 for delineator posts.

E. Raised Pavement Markers.
These markers are intended for temporary use to provide retro-reflective pavement markings. They shall be in addition to other pavement markings, when specified. The reflective surface or surfaces on the markers shall each have a minimum area of 1/2 square inch (320 mm^2), shall be of the color required, and shall provi de reflectance from approaching headlights. Markers that will be continually exposed to traffic, when installed, shall not extend more than 3/4 inch (20 mm) above the pavement surface. Markers shall be in accordance with Materials I.M. 483.07.

F. Preformed Polymer Tape.
The preformed polymer tape shall consist of glass beads imbedded in a white or yellow, polymer film which is precoated with a pressure sensitive adhesive. The contract documents will specify precut symbols and legends or tape to be made of preformed polymer marking material. The preformed polymer tape shall be a nominal width of 4 inches (100 mm).

The marking material shall be capable of adhering to asphalt and PCC surfaces and shall be prequalified as a preformed polymer tape in accordance with Materials I.M. 483.06 and meet the requirements of Article 4183.06, C.

G. Removable, Nonreflective, Preformed Tape.
Removable, nonreflective, preformed tape shall have a nominal width of 6 inches (150 mm) and shall consist of a dark grey or black, weather and traffic resistant film. The tape shall be precoated on the bottom with a pressure sensitive adhesive. The top of the tape shall be embedded with skid resistant particles. The tape shall be flexible and conform to the pavement surface. It shall be capable of remaining in place during its useful life and shall be easily removed from the pavement at any time. The tape shall not damage or discolor the underlying pavement or pavement markings.

H. Profiled Pavement Marking Tape
The profiled pavement marking tape shall consist of reflective beads imbedded in a white or yellow polymer film, which is precoated with a pressure sensitive adhesive. This marking tape has raised profiles which gives the tape higher initial retroreflectivity than the preformed polymer marking in Article 2527.02, F.

The contract documents will specify precut symbols and legends, or lane stripes to be marked with profiled pavement marking tape. Lane stripes shall have a nominal width of 4 inches (100 mm).

The tape shall be capable of adhering to asphalt and PCC surfaces and shall be prequalified as a profiled pavement marking tape in accordance with Materials I.M. 483.06 and meet the requirements of Article 4183.06, E.

I. Intersection Marking Tape.
The intersection marking tape shall consist of reflective beads and ceramic anti-skid particles embedded in a polymer film that is precoated with a pressure sensitive adhesive. This marking tape is intended for use in high wear and high shear areas such as cross walks, gore lines, and turn symbols at intersections.

The contract documents will specify precut symbols and legends or lane stripes to be marked with intersection marking tape. Lane stripes shall have a nominal width of 4 inches (100 mm).

The tape shall be capable of adhering to asphalt and PCC surfaces and shall be prequalified as a profiled pavement marking tape in accordance with Materials I.M. 483.06 and meet the requirements of Article 4183.06, E.

2527.03 CONSTRUCTION.
The contract documents will specify the quantity, locations, and type of pavement marking required.

The following chart shows the minimum allowed atmospheric and surface temperatures for application of pavement markings.

Type of Marking	Oct. 23 to Apr. 7	Apr. 8 to Apr. 22	Apr. 23 to Oct. 7	Oct. 8 to Oct. 22
Waterborne Paint	not allowed	40°F (4°C)	40°F* (4°C)	40°F (4°C)
Solvent Based Paint	no restrictions	no restrictions	not allowed	no restrictions
*Solvent-based paint may be used if temperature requirements can not be met.				

Tape and ~~epoxy~~ durable paint temperature restrictions shall be according to manufacturer's recommendations.

For all pavement markings, the pavement surface shall be dry and free from dirt, dust, oil, curing compound, and other contaminates which may interfere with the marking properly bonding to the surface. The clean surface shall be at least 1 inch (25 mm) wider than the anticipated marking. An air blast shall occur immediately prior to the new marking being placed; the air blast is not intended to remove large amounts of dust, but only a very small amount of residue that might be left from the removal and cleaning operation.

~~For tape products, the manufacturer's recommendations shall be followed for surface dryness and other surface preparation requirements.~~

All painted and taped pavement markings shall have uniform thickness, and the distribution of glass beads shall be uniform throughout the line width. The width of lines shall be as specified with tolerance of ± 1/4 inch for 4 inch (± 6 mm for 100 mm) lines and ± 1/2 inch (13 mm) for wider lines. Markings shall have sharp edges and cutoffs at the ends.

For tape products, the manufacturer's recommendations shall be followed for surface dryness, primers, adhesives and other surface preparation requirements. Unless otherwise specified by the tape manufacturer the following test shall be met for determining surface dryness before applying the tape.

1) In an area of direct sunlight where the tape will be applied, place an 18 inch x 18 inch (450 mm x 450 mm) piece of polyethylene (a green or black garbage bag can be used). There should not be any holes or tears in the polyethylene.

2) Tape down all the edges of the polyethylene sheet using duct tape or pavement marking tape. The tape should seal all the edges and not allow any air movement to get under the polyethylene.

3) Firmly tamp the tape using the tamper cart or by foot tamping.

4) Allow 20-25 minutes for the polyethylene to be exposed to the direct sunlight.

5) Remove the polyethylene from the road surface. If no moisture is present on the back side of the polyethylene or on the road surface, the tape can be applied.

6) If any moisture is present, allow another hour to pass and repeat the test until no moisture is found.

A. Traffic Control.
Traffic control for the removal and placement of painted and taped pavement markings shall be in accordance with Section 2528 with the following additional requirements:

1. Traffic control devices shall remain in place on the roadway from the time removal operations have started through the completed curing time of the newly applied pavement markings.

2. The Contractor shall not close any longer length of lane than can be adequately removed and replace in a single working day.

3. For painted pavement markings, traffic control devices shall not be removed until the newly applied pavement markings are track free.

B. Removal of Pavement Markings.
Existing pavement markings in the newly marked traffic lanes that are confusing, conflicting, or misleading to traffic shall be removed promptly on the same day the new lines are placed. The Engineer may designate other pavement markings for removal to maximize the effectiveness of the traffic control plan.

All new pavement markings, which are applied according to this specification and would change the color or placement of existing standard pavement markings shall be removed by the Contractor on completion of the project. Removal may also be required during progress of the work if lines, no longer needed, cause confusion in delineation of traffic.

Existing painted pavement markings shall be removed so that 90% or more of the pavement is visible. Tightly adhering markings may remain in the bottom of the tining and other depressions on the pavement surface but shall not be visible to the motorist during daytime or night time. Tape markings shall be removed in accordance with manufacturer's recommendations. Removal processes shall not cause functional damage to the transverse or longitudinal joint sealant materials.

Pavement marking removal operations shall be conducted in a manner so that the finished pavement surface is not damaged or left in a pattern that may mislead or misdirect the motorist. When the operations are completed, the pavement surface shall be power broomed and any marking removal debris shall be removed from the pavement surface before the pavement is open to public traffic. The limits of pavement marking removal shall be not less than the width of the existing or new pavement markings plus 1 inch (25 mm). When symbols or legends are removed, the area of removal shall cover the entire area of the existing symbol or legend.

Removal will not be required prior to being covered by a construction process unless specified in the contract documents. Removal of pavement markings may be by vacuum blasting, vacuum dry grinding, wet grinding, shot blasting, or high pressure water blasting. Open abrasive blasting or dry grinding without containment will not be allowed. In lieu of physical removal, existing pavement markings may be covered by removable, nonreflective, preformed tape. Removable, preformed, nonreflective tape shall be prequalified in accordance with Materials I.M. 483.06 and meet the requirements of Article 2527.02, G, and Article 4183.06, D.

Pavement marking removal equipment shall provide the following:

1. Operate without the release of dust.

2. Recover all removed material.

3. Include a waste collection and transfer system. For dry wastes, the system shall incorporate High Efficiency Particulate Absolute (HEPA) methods and equipment.

Removal operations may be halted if the process and final result is not acceptable to the Engineer.

Material collected shall be removed and disposed of in accordance with all applicable Federal and State regulations.

Temporary delineators, posts, and raised pavement markers shall be removed when their need no longer exists or when directed by the Engineer.

C. Pavement Marking Requirements.
The following requirements for permanent and temporary standard pavement markings for placement of the marking material shall apply:

1. Edge Lines.
Edge lines shall normally be placed approximately 3 inches (75 mm) from the edge of the pavement and shall be solid white lines, except the inside edge line for a multi-lane, divided highway (including ramps and crossovers) shall be a solid yellow line.

2. Center Lines for Two Lane, Two Way Highways.
Center lines for two lane, two way highways shall be single, dashed yellow lines 10 feet (3 m) long with 30 foot (9 m) gaps between dashes.

3. Center Lines for Multi-lane, Undivided Highways.
Center lines for multi-lane, undivided highways shall be two, solid yellow lines spaced approximately 10 1/2 inches (270 mm) apart between the inside edges of the lines.

4. Lane Lines for Multi-lane Highways.
Lane lines for multi-lane highways divided and undivided, shall be single, dashed white lines 10 feet (3 m) long with 30 foot (9 m) gaps between dashes.

5. No Passing Zone Lines.
No passing zone lines shall be solid yellow lines. For PCC surfaces, they shall be placed 3 inches (75 mm) outside a 4 1/2 inch (115 mm) center line or 3 1/4 inches (85 mm) outside a 4 inch (100 m) center line. For asphalt surfaces, they shall be 10 1/2 inches (270 mm) from the adjacent center line or no passing zone line. Where there are two no passing zone lines, the center line is to be omitted, and the no passing zone lines shall be about 10 1/2 inches (270 mm) apart between the inside edges of the lines.

It is intended that only the two outside paint nozzles be used for painting center lines and no passing zone lines on asphalt surfaces. Painting equipment should be equipped to change from solid line to a dashed line on the two outside paint nozzles.

6. Dotted Lines.
Dotted lines are usually single, white dotted lines 2 feet (0.6 m) long with 4 foot (1.2 m) gaps between dots.

7. Transverse Marking.
Transverse marking will be shown in the contract documents.

8. Symbols and Legends.
Symbols and legends will be shown in the contract documents. Each of the following is a complete unit: each RxR marking for railroad and highway grade crossing; each SCHOOL legend (one lane or two lane); each STOP, X-ING, ONLY, BUS, LANE: each arrow (straight, left, right, combination, or ramp).

9. Solid White Barrier Lines.
Solid white barrier lines may also be required in the contract documents.

D. Limitations.
When temporary marking is required to replace marking obliterated by construction, the marking shall be applied on the same working day the previous marking is obliterated.

When temporary marking is required for diversions and on site detours, the marking shall be completed and delineators placed, if required, before the diversion or on site detour is put into service, but misleading or conflicting lines shall be removed the same day the new lines are placed.

When temporary marking is required because of changes resulting from stage construction, the application shall be coordinated with other work and with the transfer of the traffic, as directed by the Engineer.

For final surfaces, marking material which is to extend diagonally across a traffic lane and is to be later removed shall be removable marking tape.

When permanent markings are placed on newly completed PCC pavements, the existing curing compound film shall be removed from horizontal surfaces. Curing compound film need not be removed from curbs or other vertical surfaces. Removal shall not damage the underlying PCC pavement.

Permanent marking shall be completed before the road is opened to public traffic. When public traffic is allowed on the pavement during construction, permanent marking of edge lines on Interstate pavements and those described in Article 2527.03, F, 2, and center lines, lane lines, and no passing zone lines, shall be completed each day where these markings have been obliterated. Other edge lines shall be placed within 3 working days from the day the pavement and shoulder work are completed for the project. Symbols and legend shall be placed within 5 working days from the day the final surface is placed at that location.

When the installation of preformed polymer pavement marking material or profiled pavement marking tape is in conjunction with placement of hot mix asphalt mixtures, the ~~preformed polymer~~ tape shall be inlaid by positioning on the hot mixture prior to the final rolling. The installation of ~~preformed polymer marking material~~ the tape shall be in accordance with the manufacturer's recommendations. If grooving is specified, tape shall not be inlaid into hot asphalt.

If, due to unavoidable circumstances, the Contractor is not able to complete the temporary or permanent pavement marking or removal specified for that day, the Contractor shall provide or continue to provide traffic control until the pavement marking work is completed.

E. Permanent Pavement Marking.
When permanent marking is required, the Contractor shall place center lines, lane lines, no passing zone lines, edge lines, barrier lines, transverse lines, symbols, legend, and other marking required by the contract documents or by the Engineer. Permanent marking will normally be required, in accordance with this specification, for all projects on which public traffic is allowed during construction. All lines shall be accurately placed to a close tolerance using a guide extending at least 3 feet (1 m) ahead of the machine. The location of edge lines may be referenced to the pavement edge. The locations of other longitudinal lines may be referenced to accurately located longitudinal joints. Where such references do not exist or are not reliable, the lines shall be located as follows:

1. For straight or nearly straight lines, the locations shall be referenced to a stringline set between marking line points.

2. For curves, the locations shall be referenced to closely spaced marking line points; for sharp curves, a spacing of 10 feet (3 m) may be required.

3. Other equally effective systems approved by the Engineer.

F. Temporary Pavement Marking.
The location of temporary pavement marking will be shown in the contract documents or as directed by the Engineer.

Temporary pavement marking shall include the following:

1. Diversions.
For diversions on divided highways, the roadways shall be temporarily marked as follows:

a. The traffic lane or roadway for traffic that is not diverted shall be marked with a continuous yellow inside edge line in the approach taper, continuing as a no passing zone line through the diversion along the existing lane line.

b. For traffic that is to be diverted, a continuous, yellow line shall be constructed as a left edge line through both crossovers, continuing as a no passing zone line through the diversion.

c. A white edge line shall be constructed on the right pavement edge, for traffic that is to be diverted, through the diversion and both crossovers.

2. On Site Detours.
On site detours for two way traffic shall be marked with two continuous no passing zone lines near the center of the roadway and two continuous white edge lines, one at each pavement edge. On site detours for one lane traffic shall have two continuous white edge lines, one at each pavement edge. The markings are to be temporary unless otherwise designated.

3. Marking Changes Resulting from Stage Construction.
On all sections of Primary Road open to traffic during construction activities, the Contractor shall place center lines, lane lines, no passing zone lines, and edge lines necessary for the construction stage, as shown in the contract documents or as directed by the Engineer.

4. Temporary Delineators.
Temporary delineators, when required, shall be erected as shown in the contract documents. If not shown, they shall be spaced at intervals described in Section 3D-5 of the MUTCD. Temporary delineators will usually be single, white reflectors which are to be placed 2 feet (0.6 m) beyond the outside edge of the shoulder and 4 feet (1.2 m) above the edge of the pavement on delineator posts.

5. Raised Pavement Markers.
Raised pavement markers shall be placed parallel to the line being marked at that location. Placement shall be in accordance with the manufacturer's recommendations subject to approval by the Engineer.

G. Markings Obliterated During Construction.
On all sections of a Primary Road open to traffic, the Contractor shall place temporary or permanent pavement markings on any part where construction operations have obliterated the existing marking. Temporary or permanent pavement marking shall be replaced for the following situations:

1. If center lines or lane lines or both have been obliterated on sections of roadway for a distance of 50 feet (15 m) or more on curves with a radius of 300 feet (90 m) or less, 90 feet (25 m) or more on curves with a radius of 300 feet (90 m) to 1,000 feet (300 m), and 300 feet (90 m) or more on curves with a radius of more than 1,000 feet (300 m) or on straight sections.

2. If edge lines have been obliterated on sections of roadway for a distance of 50 feet (15 m).

a. On all Interstate and multi-lane, divided highway;

b. On all Primary highways at curves with radius of 1,000 feet (300 m) or less (not necessary for straighter sections and tangents);

c. On all Primary highways at approaches, for a distance of 300 feet (90 m), to bridges, or elsewhere where there is an obstruction within 3 feet (1 m) of the pavement edge.

3. If No Passing Zone lines have been obliterated.

4. For HMA resurfacing when the Contractor is required to bring the final lift of adjacent lanes approximately to the same location, the following shall apply to the final lift:

a. For two way highways, the center line and no passing zone lines along short, longitudinal drop-offs that remain need not be marked. When the drop-off extends more than 300 feet (90 m) due to unavoidable circumstances, reconstruction of these lines will be required.

b. For multi-lane highways, lane lines along short, longitudinal drop-offs that remain need not be marked. When the drop-off extends more than 300 feet (90 m) due to unavoidable circumstances, lane lines will be required. Center line on undivided highways shall be reconstructed each day with one or two solid yellow lines, as necessary if markings have been obliterated, so as to maintain a center line of two solid lines.

H. Defective ~~Epoxy Paint~~ Pavement Markings.

~~**1. Insufficient Film Thickness, Line Width, or Low Retroreflectivity.**~~

~~**Repair Method.** Prepare the surface of the defective epoxy paint marking using methods found in Article 2527.03. Surface preparation shall be performed to the extent that a substantial amount of the retroreflective glass beads are removed and a roughened epoxy marking surface remains. Repair shall be made by restriping over the cleaned surface in accordance with the requirements of these specifications and at the full thickness.~~

~~**2. Insufficient Bond.**~~

~~**Repair Method.** The defective epoxy paint marking shall be completely removed and cleaned to the underlying pavement surface in accordance with the requirements of Article 2527.03. The extent of removal shall be the defective area plus any adjacent epoxy paint pavement marking material extending 1 foot (300 mm) in any direction. After surface preparation work is complete, repair shall be made by reapplying epoxy paint over the cleaned pavement surface in accordance with the requirements of these specifications.~~

Markings that are low on initial retroreflectivity up to 20%, may at the discretion of the Engineer, be accepted with a price adjustment ~~equal to the percent below the minimum retroreflectivity level. For example, if a section of marking is 15% below the minimum, the price paid for that section would be reduced by 15%~~. Pavement markings, which after application and curing are determined by the Engineer to be defective and not in conformance with theses specifications shall be repaired. The defective markings shall be completely removed and cleaned to the underlying pavement surface in accordance with the requirements of Article 2527.03, B. The extent of removal shall be the defective area plus any adjacent marking material extending 1 foot (300 mm) in any direction. After surface preparation work is complete, repair shall be made by reapplying new marking material over the cleaned pavement surface in accordance with the requirements of these specifications.

All work in conjunction with the repair or replacement of defective ~~epoxy paint~~ pavement markings shall be performed by the Contractor at no additional cost to the Contracting Authority.

I. ~~Surface Preparation for Profiled Marking Tapes~~ Grooving for Pavement Markings.
~~All profiled~~ When specified, pavement markings shall be placed in a groove cut into the pavement surface. The groove shall be made in a single pass, dry or wet cut using stacked diamond cutting heads mounted on a floating head with controls capable of providing uniform depth and alignment. The dry cutting equipment shall be self vacuuming. The equipment and method used shall be recommended by the manufacturer.

The groove shall meet the following specifications:

1. Groove width.
Tape width plus 1 inch (25 mm) minimum.

2. Groove depth.
For profiled marking tape the groove depth shall be ~~0.065 inches ±0.020 inches (1.6 mm ±0.5 mm)~~ 0.080 inches ± 0.010 inches (2.0 mm ± 0.03 mm).

For all other markings, the groove depth shall be as recommended by the pavement marking manufacturer.

3. Groove length.
Full length of tape plus 3 inches (75 mm) minimum grooving transition on either end. A continuous groove shall not be allowed for dash markings.

4. Groove position.
Minimum of 2 inches (50 mm) from edge of the longitudinal joint.

5. Finished surface.
The bottom of the groove should have a fine corduroy-like texture. The maximum allowable rise between the high and low points across the width of the groove is 0.010 inch (0.25 mm).

6. Groove cleaning.
Dry cut grooves shall be vacuumed and broomed with the final cleaning done with a high pressure air blast. If wet cutting is used, the groove shall be immediately flushed with water. The removed material shall be recovered. The surface shall be allowed to dry to a visibly dry condition. The surface to receive the tape shall be free from dust, dirt, or other contaminates that may interfere with the tape properly bonding, and shall pass the following moisture test before tape is placed:

~~**a. Moisture Test of Pavement Surface.**~~

~~**1)** In an area of direct sunlight where the tape will be applied, place an 18 inch x 18 inch (450 mm x 450 mm) piece of polyethylene (a green or black garbage bag can be used). There should not be any holes or tears in the polyethylene.~~

~~**2)** Tape down all the edges of the polyethylene sheet using duct tape or pavement marking tape. The tape should seal all the edges and not allow any air movement to get under the polyethylene.~~

~~**3)** Firmly tamp the tape using the tamper cart or by foot tamping.~~

~~**4)** Allow 20-25 minutes for the polyethylene to be exposed to the direct sunlight.~~

~~**5)** Remove the polyethylene from the road surface. If no moisture is present on the back side of the polyethylene or on the road surface, the tape can be applied.~~

~~**6)** If any moisture is present, allow another hour to pass and repeat the test until no moisture is found.~~

~~**7. Adhesive.**~~
~~The Contractor shall apply adhesive according to the manufacturer's instructions.~~

2527.04 MAINTENANCE.
Pavement marking, symbols and legends, temporary delineators, and raised pavement markers, for which the Contractor is responsible, shall be maintained in good condition, and shall be replaced, if necessary, for the period of their intended use. Their condition shall be subject to review by the Engineer.

2527.05 METHOD OF MEASUREMENT.
Pavement markings, symbols and legends, temporary delineators, and raised pavement markers, satisfactorily placed or approved, will be measured as follows:

A. Painted Pavement Marking.
The Engineer will measure the number of stations (meters) of Painted Pavement Markings of the type specified placed with traffic paint. This includes both permanent and temporary pavement marking.

B. Permanent Tape Marking.
The Engineer will measure the number of stations (meters) of Permanent Marking Tape marking placed of the type specified in the contract documents.

C. Removable Tape Marking.
The Engineer will measure the number of stations (meters) of Removable Marking Tape placed. The removing of removable tape will not be measured separately for payment.

D. Painted Symbols and Legend.
The Engineer will count each Painted Symbol and Legend of the type specified complete as a unit placed with traffic paint.

E. Precut Symbols and Legend.
The Engineer will count each Precut Symbol and Legend as a complete unit placed with the marking tape specified in the contract documents.

F. Temporary Delineators.
The Engineer will count the number of Temporary Delineators installed.

G. Raised Pavement Markers.
The Engineer will count the number of Raised Pavement Markers installed.

H. Pavement Marking Removed.
The Engineer will measure the number of stations (meters) of Pavement Marking Removed. Pavement markings obliterated during construction that are of removable marking tape, or removed by the Contractor on the Contractor's own accord, will not be measured separately for payment.

I. Symbols and Legend Removed.
The Engineer will count each Symbol and Legend removed, symbols and legends obliterated during construction, or removed by the Contractor on the Contractor's own accord will not be measured separately for payment.

J. Removable, Nonreflective, Preformed Tape.
The Engineer will measure the number of stations (meters) of Removable, Nonreflective, Preformed Tape placed. The removal of the tape will not be measured separately for payment.

K. Grooves Cut for ~~Tape~~ Pavement Markings.
~~For Grooves Cut for Profiled Marking Tape, t~~The Engineer will measure the number of stations (meters) of grooves cut for ~~tape~~ pavement markings. This quantity will be equivalent to the number of stations (meters) measured for ~~Preformed Polymer Pavement Marking~~ ~~tape~~ pavement markings. Additional width and transition length will be incidental.

L. Grooves Cut for Symbols and Legends.
The Engineer will count the number of Grooves Cut for Symbols and Legends placed. Each symbol or legend groove will be counted as a complete unit.

The Engineer will measure the number of stations (meters), based on a single 4-inch (100 mm) width, or painted, taped, and/or removed line. The length of each type of markings will be determined using beginning and ending points, and adjusting for breaks at side roads, median crossings, station equations, or other locations shown in the contract documents. The measurement for dashed and dotted lines will be adjusted to exclude skips. Measurement of lines wider than 4 1/2 inches (115 mm) will be adjusted by the quantity factor to a 4 inch (100 mm) line.

2527.06 BASIS OF PAYMENT.
The quantities of pavement marking, symbols and legends, temporary delineators, and raised pavement markers, satisfactorily placed or removed, will be paid as follows:

A. Painted Pavement Marking.
For the number of stations (meters) of Painted Pavement Marking of the type specified, placed with traffic paint, including both temporary and permanent marking, the Contractor will be paid the contract unit price per station (meter).

B. Permanent Tape Marking.
For the number of stations (meters) of Permanent Tape Marking placed with the type of marking tape specified in the contract documents, the Contractor will be paid the contract unit price per station (meters).

C. Removable Tape Marking.
For the number of stations (meters) of Removable Tape Marking placed, the Contractor will be paid the contract unit price per station (meter). This payment includes removing the removable marking tape, when required.

D. Painted Symbol and Legend.
For each unit of Painted Symbol and Legend of the type specified, placed with the type of traffic paint, specified in the contract documents, the Contractor will be paid the contract unit price.

E. Precut Symbol and Legend.
For each Precut Symbol and Legend placed marking tape specified in the contract documents, the Contractor will be paid the contract unit price.

F. Temporary Delineators.
For each Temporary Delineator installed, the Contractor will be paid the contract unit price.

G. Raised Pavement Markers.
For each Raised Pavement Marker installed, the Contractor will be paid the contract unit price.

H. Pavement Markings Removed.
For the number of stations (meters) of Pavement Markings Removed, the Contractor will be paid the contract unit price per station (meter).

I. Symbols and Legends Removed.
For the number of Symbols and Legend Removed, the Contractor will be paid the contract unit price for each.

J. Removable, Nonreflective, Preformed Tape.
For the number of stations (meters) of Removable, Nonreflective, Preformed Tape placed, the Contractor will be paid the contract unit price per station (meter). This payment includes removal of the tape and repairing damage to the existing pavement markings caused by the tape.

K. Grooves Cut for ~~Tape~~ Pavement Markings.
For the number of stations (meters) of Grooves Cut for Tape, the Contractor will be paid the unit price per station (meter).

L. Grooves Cut for Symbols and Legends.
For the number of Grooves Cut for Symbols and Legends, the Contractor will be paid the contract unit price for each.

These payments shall be full compensation for cleaning, surface preparation, and application of temporary and permanent pavement markings, symbols and legends, maintenance, removal of pavement markings or symbols and legends, installing or removing temporary delineators, installing or removing

raised pavement markers, and for furnishing all materials, equipment and labor, and disposal of material generated from the removal operations.